PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of

Eik BEZZEL et al. Attn: PCT Branch

Application No. New U.S. National Stage of PCT/DK03/00405

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For: AN OPTICAL ELEMENT FOR SHIELDING AGAINST LIGHT

SUBMISSION OF THE ANNEXES TO THE INTERNATIONAL PRELIMINARY EXAMINATION REPORT

Commissioner for Patents
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Sir:

Attached hereto is a submission of the annexes to the International Preliminary Examination Report (Form PCT/IPEA/409). The attached material replaces the material in pages 3-5, 9-10, and 32 and claims 1-3.

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from which angles of incidence light are allowed to pass and not to pass, respectively, the blind. However, Venetian blinds are associated with the drawback that, due to the size of the lamella, they are extremely visible and thus substantially obstruct the general view through a window provided with a Venetian blind.

Another way of dimming incident sun light is by means of tinted glass panes, eg in the form of a dyeing of the glass or adherence of optical filters directly on the area of glass. These window panes reduce both the directly incident radiation from the sun and the indirect radiation proportionally, irrespectively of the angle of incidence of the radiation. There are no visible shielding elements as such and the view is therefore not obstructed directly, but an indirect influence on the view will occur though, as light from all direction is, as mentioned, dimmed to the same extent. This means that if the shielding against the directly incident solar radiation is to have any effect at all, the window panes will appear to be very dark on days or at times when there is no direct sunlight. Also, these window panes will typically have a tinting that differs from that of ordinary glass panes, whereby the perception of the colour of objects viewed through such pane can be disturbed. The external appearance of a building is also affected when tinted panes are used, but such effect, however, is not necessarily undesired.

In DE 100 34 197 a transparent foil is disclosed, which on its inward side is covered with an almost light-tight coating. The foil can be attached to the inner side of a window, and the light-tight coating may be provided with small holes so that it is possible to look through the window while the incident light is reduced. The effect corresponds to the tinted glass panes mentioned above, and also this solution reduces both the directly incident radiation from the sun and the indirect radiation proportionally, irrespectively of the angle of incidence of the radiation.

WO 02/35046 shows a cell structure arranged between two glass plates. The cell structure is made up by tube pieces allowing unhindered view through the structure in one direction of viewing, i.e. parallel to its orientation, while visual access is blocked from other directions. However, the tube pieces providing the structure are not small enough to be substantially invisible.

Furthermore, Danish patent application DK PA 1998 01040 teaches a solar cell, whose substrate is constituted by a plate of extended metal which, when mounted vertically, is able to shield against the sun without completely shielding against the view through the plate. It is mentioned that if the plate is viewed from sufficiently far away, it will seem to be invisible, but the described plate will not be invisible at the distances that are relevant in a room with the plate mounted on eg a window pane.

It is an object of the invention to provide an optical element of the above-referenced kind that is, to a higher degree than the prior art solutions, able to reduce the problem of the heating of the interior of a building that takes place due to incident solar radiation without the indirect radiation and hence the view through the element being significantly reduced.

In the optical element the transparent areas are arranged sufficiently close to each other for the individual, intermediate, essentially non-transparent areas to be substantially invisible to the naked eye, at least when the element is viewed at a given distance that corresponds, however, at most to distances in indoor facilities, and the essentially non-transparent areas are arranged sufficiently close to each other and have a sufficient extent perpendicular to the face for the intermediate transparent areas to have a depth-to-width ratio that causes the optical element to allow, at a given point on the face, light to pass at certain angles of incidence, while light with other angles of incidence are unable to pass the optical element at the relevant point.

According to the invention the object is achieved in that the optical element comprises a structure that constitutes at least a part of a solar cell. Hereby the effect is obtained that, in addition to shielding against the direct sunlight from the sun when high in the sky, the optical element is also capable of converting the absorbed sunlight into electrical energy. Thus the element is able both to reduce the heating due to incident sunlight – and hence in itself the need for cooling – and simultaneously produce electrical energy that may be used e.g. for cooling the building. Overall, considerable savings are obtained in the energy consumption of a building that originates from solar heating, while simultaneously the indoor climate in the relevant rooms is not adversely affected.

Such arrangement of the transparent areas so close to each other that the intermediate areas are more or less invisible in case of usual indoor viewing distances ensures that, from an overall point of view, the element is more or less invisible and thus does not considerably prevent the view through the element. The depth-to-width ratio of the transparent areas precludes light from these angles to travel through the element. Thus, if the element is arranged such that precisely light from the sun when high in the sky is blocked, while light from lower points are allowed to pass, the desired effect is obtained.

The described optical element is able to serve as an optical filter having the particular property that its ability to absorb and reflect the light depends on the angle of incidence of the light in relation to the element. For instance, the optical element can be configured and located such that it allows incidence of light when the angle of incidence of light in relation to the element is large, while it effectively absorbs light with a small angle of incidence in relation to the element. In this particular embodiment, the effect is obtained that a vertically arranged element removes considerable amounts of the incoming direct solar radiation, when the intensity of the sun light is high in the middle of the day, while the element allows incidence of light from and view in directions

close to the horizon. Thus, the optical element will be perceived as transparent, albeit shielding, for as long as the user views objects that are close to the horizon through the element.

By the optical element the effect is obtained that the incoming heat radiation from the sun through the optical element is reduced when the sun is high in the sky in the middle of the day. Simultaneously the element allows the user to look through the element for as long as the viewing angle is smaller than the limit set therefor, and the element appears as a uniform, coherent face, eg as a plane element. Hereby the element differs considerably from conventional sun shielding products, such as eg Venetian blinds and lamellae curtains that are, on the one hand, visible as such and, on the other, do not constitute a coherent, uniform face in relation to the pane or the doorway in which such elements are to be mounted.

Since the optical element reduces the direct solar radiation into the building, the need to cool the building is considerably reduced, and the optical element will thus be of much value in interaction with the building, as the element lowers the overall energy consumption of the building. In connection with office buildings that often feature a considerable amount of glass panel fronts, the primary energy consumption of the building is closely related to the need for cooling.

as solar cells. As above, this means that the optical element has both a shielding and an energy-producing effect. In this case, the solar cells can be configured as thin film solar cells.

The invention will now be described in further detail with reference to the drawing, wherein

Figures 1a-c show an optical element with circular apertures;

Figures 2a-d show an optical element with elongate apertures;

Figure 3 shows how an optical element shields against light with specific angles of incidence;

Figure 4 shows reflection of light from the lamellae of an optical element;

Figures 5a-c show an optical element, wherein non-transparent islands are used;

Figures 6a-c show an optical element wherein channels extend in the entire width of the element;

Figures 7a-c show an optical element, wherein the individual lamellae are of triangular cross section;

Figures 8a-c show an optical element with tilted lamellae;

Figures 9a-b show a solar cell with a photo electrode configured as a raster plate according to the invention;

Figure 10 is a sectional view through a solar cell with a counter electrode configured as a raster plate according to the invention;

Figure 11 shows an optical element, wherein a layer of solar cells is applied to the surface; and

Figure 12 shows an optical element with irregular structure.

Figures 1a-c show an example of an optical element 1. In the example shown the element 1 consists of an essentially non-transparent film or plate material provided with a number of through-going apertures or openings 2 evenly distributed across the area of the plate. Such plate with through-going apertures in a regular pattern will, in the text that follows, be designated a raster plate. In the optical element 1 shown in Figure 1 the apertures are circular. Figure 1a shows the plate 1 seen in a view straight from the front, while Figure 1b is a sectional view along line b-b in Figure 1a. Figure 1c shows the optical element 1 seen in a perspective view. The optical element 1 shown in Figures 1a-c is shown as a small element with only 20 circular apertures in the plate. In practice, it will usually be much larger plates with far more apertures. Herein, the small plate is used for better illustrating the way in which the optical element works.

If the raster plate is made of an absorbing or reflecting material, a shielding will be obtained that is symmetrical around the face normal of the plate. This means that incoming radiation from eg the sun will be absorbed and/or reflected when it forms a small angle in relation to the raster plate; ie an angle smaller than the angle θ in Figure 1b, whereas light from larger angles pass right through the apertures 2. This means that the viewing angle through said element 1 is restricted just as much upwards as to each side, if the element is arranged vertically eg in the front façade of a building.

Patent claims:

1. An optical element (1; 11; 21; 31; 41; 51; 61; 71; 81) in the form of an at least partially transparent face that comprises both transparent areas and essentially non-transparent areas, wherein

- the transparent areas are arranged sufficiently close to each other for the individual, intermediate, essentially non-transparent areas to be essentially invisible to the naked eye, at least when the element is viewed from a given distance that corresponds, however, at most to distances within an indoor-facility; and
- the essentially non-transparent areas are arranged sufficiently close to each other and have a sufficient extent at right angles to the face for the intermediate, transparent areas to have a depth/width ratio that causes the optical element to allow, at a given point on the face, passage of light with given angles of incidence, while light having other angles of incidence are unable to pass through the optical element at the point in question,

characterized in that

- the optical element comprises a structure that constitutes at least a part of a solar cell.

2. An optical element according to claim 1, characterised in that said essentially, non-transparent areas constitute a continuous face, such that the transparent areas appear as openings (2; 12, 13) in this face.

3. An optical element according to claim 2, characterised in that said openings are elongate, whereby they have, in a given direction in the plane of the face, an extent that considerably exceeds the extent in a direction at right angles thereto in the plane of the face.